



ONTARIO DEPARTMENT OF EDUCATION


# ELEMENTS OF CONSTRUCTION TECHNOLOGY

SENIOR DIVISION

1969



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SENIOR DIVISION



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## FOREWORD

This publication contains a curriculum outline, Elements of Construction Technology, for use at the senior grades in Ontario secondary schools. The outline, which combines Architectural Drafting and Building Construction in one integrated subject, has been organized into three parts: Division 1, "Core", contains material which is common to both Division 2, "Architectural Drafting", and Division 3, "Building Construction Practices".

An integrated course combines two or more subjects that have common or complementary content. The two disciplines embraced by Elements of Construction Technology are closely related and can be integrated easily. Two teachers, however, are required for the implementation of this course: each should be an authority in his own area and have broad experience in the construction industry.

At the secondary school level, fundamentals are more important than the treatment in depth which characterizes the tertiary levels of education. An integrated approach is desirable because students understand basic principles best if they are able to relate them to several subjects. Teachers should emphasize the close relation of technical subjects to mathematics, science, English, and history so that technical subjects become effective educational vehicles as well as a means of learning skills.

Approximately sixty per cent of the available time should be devoted to student activity that reinforces theoretical work. The teacher may, however, be able to increase this ratio by use of an individual progress approach.

The amount of material in this course outline is based on the assumption that a total of approximately six hundred hours is available. If this is not the case, the teachers must decide which units can be studied. Abbreviated courses may be offered to meet the needs of various groups of students.

Since the course is a two-year entity, arrangement of subject material into weekly, monthly, and yearly sequences is the task of the teachers. Although the arrangement of the outline is logical, it is not chronological: it is an analysis of subject content, not a synthesis. No attempt has been made to arrange these topics in a teaching sequence, nor has any attempt been made to integrate the topics of the three divisions: these tasks are reserved for the professional teacher. The participating teachers

must consult frequently: if possible, two or more periods per week should be set aside so that course construction, lesson planning, and evaluation can be pursued as a team effort.

Students should feel they are taking one technical subject. This may be accomplished by innumerable arrangements and varieties of presentation. To illustrate the manner in which a given topic relates to all divisions, one might consider "Foundations," which can be related to the following:

- 12.1 Site development evaluation
- 121.3 Soil mechanics
- 12.2 Construction surveys
- 12.3 Excavation
- 13.1 Concrete
- 13.2 Wood
- 13.3 Masonry and masonry bonding materials
- 14.2 Requirements of a building
- 142.3 Resistance to loads imposed on the building
- 142.4 Resistance to loads imposed by the structure
- 14.3 Structural elements of a building
- 15.1 Structural design
- 151.4 Design
- 16.2 Water supply and disposal systems
- 21.2 Graphic communication methods
- 212.2 Orthographic projection
  - plans, elevations, sections and details
- 32.2 Structural concrete
- 322.2 Formwork
- 322.3 Reinforcing

This list illustrates the fact that the course outline offers an organization of content, but does not inhibit the teachers from developing a coherent sequence related to the particular requirements of their classes and the facilities at their disposal.

## AIMS AND OBJECTIVES

The primary aims of technical education are identical with those of education as a whole: developing each student's personality and capabilities, and giving him constructive attitudes towards himself and society.



Any technical curriculum should (1) provide a sound educational base from which further education or training may proceed, (2) prepare for employment by the development of basic technical skills.

The proper focus of the technical disciplines at the secondary school level is technology. Technology involves science, mathematics, English, art, economics, and history as well as technical and trade skills; thus, the integration of technical subjects with other subjects becomes feasible.

Objectives of Elements of Construction Technology are:

- a positive attitude toward learning
- an educational foundation for further education and/or training
- preparation for advancement in the building industry as a whole
- an awareness of a continually changing social and technological world
- an appreciation of relationships among the humanities, sciences, and the technologies
- an overview of the construction industry
- the ability to think in three-dimensional concepts
- a knowledge of the organization of the various trades activities for a building project
- manipulative skills which will prepare the more practically-minded student to enter his chosen field
- mature attitudes and good work habits

The teacher of Elements of Construction Technology should endeavour to develop his students' ability to:

- work amicably with others
- assume responsibility and work independently of supervision
- appreciate and practice good safety practices
- plan work schedules
- develop skill in the communication of technical topics

- use resource material in compiling technical reports
- apply mathematical and scientific principles
- use measuring instruments and hand tools
- visualize and draw architectural components.

## SAFETY

The responsibility for designing and equipping safe technical areas rests with the board of education. Safe working and teaching conditions are the responsibility of the teacher and the technical director.

The teacher of building construction has an excellent opportunity to condition his students in safety practices in the correct use of tools and equipment. Not only should he describe potential dangers and possible unsound practices, but he must encourage students to "think safety" at all times.

Teachers should invite representatives of recognized industrial safety organizations to inspect the technical department and to assess safety practices within the teaching areas. In addition, these representatives might be asked to speak to the teachers and students on modern safety practices.

## FIELD TRIPS

Students of Elements of Construction Technology will benefit greatly from frequent field trips to construction sites and architectural drafting offices. Of particular interest will be heavy industrial projects which are beyond the scope of the school shop facilities. In addition, students will learn to appreciate local architecture by visits to interesting structures within the community.

# ORGANIZATION

## DIVISION 1: CORE

- Units**
- 1.1 The Construction Industry
  - 1.2 Site Development
  - 1.3 Building Materials
  - 1.4 Community and Building Analysis
  - 1.5 Design of Building Elements and Components
  - 1.6 Building Services

## DIVISION 2: ARCHITECTURAL DRAFTING

- Units**
- 2.1 Graphic Communication
  - 2.2 Architectural Development and Appreciation

## DIVISION 3: BUILDING CONSTRUCTION PRACTICES

- Units**
- 3.1 Residential Construction
  - 3.2 Commercial and Industrial Construction
  - 3.3 Construction Safety



## DIVISION 1: CORE

### INTRODUCTION

The complementary nature of architectural drafting and building construction makes it possible to consider all the material as core. There appears, however, to be some advantage in illustrating a breakdown of material between two teachers; hence, three divisions have been maintained.

This division contains material for teachers to draw from at will. The mutual objective of the participating teachers is to present the subject in such a way as to obtain maximum reinforcement of essential concepts. As with the other divisions, the course of study must be developed by a team effort: it is quite possible that the teachers will present information on all topics.

Units 1.4 and 1.5 are included in the Core Division with the idea of presenting only the functions of various components. The same sections would be expanded in Division 2 through drawings, and in Division 3 by constructing building elements.

Unit 1.6, Building Services, contains specialized trade knowledge; the technical director might, therefore, organize short periods of concentrated study conducted by teachers of each specialty. The students of electrical and construction technology could, for instance, exchange major shops for two weeks.

### UNIT 1.1 THE CONSTRUCTION INDUSTRY

#### **Organization**

Ownership  
Regulations  
Designers  
Personnel  
Construction  
Materials

#### **Economics**

Owner and representatives  
Contractors

#### **Estimating**

Units  
Preliminary  
Detail  
Scheduling: Critical Path, bar graph

#### **Documents**

Contracts  
Tendering  
Drawings and specifications  
Guarantees

### UNIT 1.2 SITE DEVELOPMENT

#### **Evaluation**

Preliminary investigation  
Detail investigation  
Soil mechanics

#### **Construction surveys**

Instruments  
Construction lines  
Elevation and grades

#### **Excavation**

General  
Special Techniques (0)  
Drainage

### UNIT 1.3 BUILDING MATERIALS

#### **Concrete**

Cements  
Aggregates  
Design and control of mixes

#### **Wood**

Structure and classification  
Manufacture of lumber

Wood diseases  
Seasoning of lumber  
Grading of lumber  
Plywoods  
Composition board

**Masonry and masonry bonding materials**

Blocks  
Brick  
Tile  
Stone  
Mortars

**Metals**

Ferrous  
Non-ferrous

**Insulators**

Acoustical  
Thermal  
Vapour

**Protective and decorative**

Paint and varnishes  
Glass  
Plastics

**UNIT 1.4 COMMUNITY AND BUILDING ANALYSIS  
ANALYSIS**

**Community planning**

Shelter  
Recreation  
Landscape  
Services  
Circulation  
Zoning

**Requirements of a building**

Accommodation  
Internal environment  
Resistance to loads imposed on the building  
Resistance to loads imposed by the structure  
External environment

**Structural elements of a building**

Vertical elements  
Horizontal elements  
Special elements

**Non-structural elements of a building**

Space enclosing elements  
Vertical circulation elements  
Service elements

**External elements**

Landscaping  
Pavement

**UNIT 1.5 DESIGN OF BUILDING ELEMENTS  
AND COMPONENTS**

**Structural**

Requirements  
Materials  
Deformation of materials  
Design  
Sizing and joining

**Non-structural**

Moisture control  
Temperature control  
Light control  
Sound control  
Space and circulation control  
Surfaces  
Fitments

**UNIT 1.6 BUILDING SERVICES**

**Electrical**

Sources and distribution  
Power  
Lighting  
Communication  
Heating

**Water supply and disposal systems**

Sources  
Potable water distribution  
Sewage  
Water disposal

**Gas systems**

Sources  
Distribution  
Uses

**Heating systems**

Water  
Steam  
Air  
Electrical resistance

**Air conditioning**

Ventilating  
Conditioning

## DIVISION 2: ARCHITECTURAL DRAFTING

### INTRODUCTION

This division deals with the knowledge and skills of the architectural draftsman. The graduate of this course will need a balance of various skills: the ability to visualize objects in three dimensions, knowledge of drafting instruments, materials, and techniques, competence in the preparation of drawings, an appreciation of aesthetics, an awareness of architectural styles, and a familiarity with building materials and practices.

The teacher should guard against over-emphasis on any single facet of the course so that the student can form a sound basis for future development.

The experience in the building construction shop should be integrated, as much as possible, with drafting activities. For example, the student can design and draw objects which he subsequently builds.

The historical unit on architectural development can be presented by the discovery method. Students can review the contributions to the construction industry of famous architects and engineers, especially those who have lived within the past century. Many localities have numerous buildings of historical interest, both from the point of view of style and design. An analysis based upon first-hand experience, of one or more of these structures might be included in the historical unit.

### UNIT 2.1 GRAPHIC COMMUNICATION

#### **Instruments and materials**

Instruments  
Surfaces  
Reproduction

#### **Methods**

Basic techniques  
Orthographic projection  
Axonometric projection  
Perspective  
Rendering  
Modular drafting  
Models

#### **Drawings**

Preliminary  
Working and detail  
Shop

### UNIT 2.2 ARCHITECTURAL DEVELOPMENT AND APPRECIATION

#### **Periods**

Ancient  
Mediaeval  
Modern

#### **Personages**

Architects  
Engineers

## DIVISION 3: BUILDING CONSTRUCTION PRACTICES

### INTRODUCTION

In organizing the construction part of the course, the building construction teacher should take special note of Unit 3.2 which should take a position of importance equal to Unit 3.1. Requirements of geographical regions may alter this ratio to some extent but not to the exclusion of either unit. Generally, Unit 3.1 will be presented before Unit 3.2; the chance to integrate parts of both units, however, should not be overlooked. In presenting both units, the instructor will undoubtedly wish to make field trips and on-site inspection of projects to acquaint the students with techniques and processes which may not be carried on in the classroom. Unit 3.3 will be introduced at every possible opportunity throughout the entire course.

Integration of content between Divisions 2 and 3 will require maximum co-operation between the participating teachers. The study of materials, their applications, and installation constitute a major portion of the course. The practical work should emphasize techniques of cutting, shaping, fitting, and joining, as well as measurement, accuracy, degrees of quality, and testing procedures.

### UNIT 3.1 RESIDENTIAL CONSTRUCTION

#### **Foundations**

Footings  
Walls  
Slabs

#### **Framing**

Types  
Floors  
Walls  
Roofs

#### **Masonry**

Solid  
Veneer

#### **Finishing**

Exterior  
Interior

#### **Millwork**

Doors  
Windows  
Stairs  
Fitments

### UNIT 3.2 COMMERCIAL AND INDUSTRIAL CONSTRUCTION

#### **Foundations**

Simple  
Special

#### **Structural concrete**

Insitu  
Formwork  
Reinforcing  
Pre-cast concrete  
Pre-stressed

#### **Structural metals**

Steel products  
Aluminum

#### **Structural timber**

Solid units  
Laminated units

## **Structural and veneer masonry**

Structural

Facing units

Ancillary

## **Components, exterior and interior**

Walls

Finish floor

Roofs

Roof coverings

## **Cold weather procedures**

Personal protection

Building protection

Materials handling

## **UNIT 3.3 CONSTRUCTION SAFETY**

### **Engineering**

Design

Layout

Construction

### **Enforcement**

Legislated

Non-legislated

Liability

### **Education**

Accident prevention associations

Management

Labour



## BIBLIOGRAPHY — (DIVISION 1)

Anthony, G. H. *Architectural Technology*. Toronto, Sir Isaac Pitman, 1966. A Canadian textbook which covers the content of Divisions 1 and 2 in this course outline. National Building Codes and Canadian Government Specifications Board symbols and standards are used.

Canadian Institute of Steel Construction. *Handbook of Steel Construction*. Canadian Institute of Steel Construction, 1967.

A comparison of figures and formulas to aid structural engineers and designers to calculate steel members for a building.

Gaylord, E. H., and Gaylord, C. N. *Design of Steel Structure*. Toronto, McGraw-Hill, 1957.

An American text dealing with the design of structural members and their connections. Some attention is given to aluminum. The relation of theory and test to standard design specifications is emphasized. Approximate cost, \$15.00.

Halse, Albert O. *Architectural Rendering*. Toronto, McGraw-Hill, 1960. A comprehensive manual which explains techniques used to render interior and exterior buildings and components. Purchase and use of materials are well covered. Cost, \$22.00.

Hepler, D. E., and Wallach, P. I. *Architectural Drafting and Design*. Toronto, McGraw-Hill, 1965.

An American text covering architectural drafting in four parts. The first part covers residential design on a room-by-room basis. The second part, basic architectural plans, covers drafting techniques, floor plans, elevation, and pictorial drawings. Part three covers technical architectural plans involving site development, foundation and farming plans, and building services. The final part covers creative architectural drafting and design.

Horning, W. *Architectural Drafting*. 4th ed. Toronto, Prentice-Hall, 1966. The book covers dwellings and small industrial buildings. The content follows the actual order of planning and construction so the student understands "why" as well as "how", in a step-by-step sequence.

Kent, S. R. *Modular Drafting Manual*. Ottawa, National Research Council, 1961 (publication number 634).

This manual describes the sizing of modular building components and the drafting techniques for recording the position of the components on working drawings for the construction of a building.

Kidder, F. E., and Parker, H. *Architects and Builders Handbook*. New York, J. Wiley, 1931 (Rexdale, J. Wiley Canada).

Data for architects, structural engineers, contractors, and draftsmen. Cost, \$25.00.

Parker, Harry. *Simplified Design of Structural Steel*. New York, J. Wiley, 1965 (Rexdale, J. Wiley Canada).

An American text dealing with structural steel design using A.I.S.C. standards and tables. Cost \$10.00.

Parker, Harry. *Simplified Engineering for Architects and Builders*. New York, J. Wiley, 1961 (Rexdale, J. Wiley Canada).

This up-to-date revision covers the principles of mechanics, steel construction, timber construction, reinforced concrete, and roof trusses. Cost \$10.00.

Pisani, T. J. *Essentials of Strength of Materials*. Toronto, Van Nostrand Co. (Canada) Ltd., 1964.

Especially designed for high school use. No calculus being used, no mathematical background beyond algebra is assumed. Content includes vector quantities, simple stress, design of beams, essentials of plain and reinforced concrete. Cost, \$6.00.

Salvadori, M., and Heller, R. *Structure in Architecture*. Scarborough, Prentice-Hall of Canada Ltd., 1963.

Written for both class presentation and self-study. There are explanations of elementary, as well as sophisticated concepts of structural behaviour. Cost, \$13.00.

Salvadori, M., and Levy, M. *Structural Design in Architecture*. Scarborough, Prentice-Hall of Canada Ltd., 1967.

Covers methods of analysis required by preliminary design, using minimal mathematics. The book presents elementary methods of the design of frames, plates, grids, membranes, and space frames. Cost, \$13.00.

Sleeper, Harold R. *Building Planning and Design Standards*. New York, J. Wiley, 1955 (Rexdale, J. Wiley Canada).

A graphic analysis of twenty-three building types ranging in size from small homes to air terminals. For each type there is a chapter on program data, spatial relationships, area requirements, typical plans, basic data on furniture, fixtures, and equipment. Cost. \$22.00.

Smith, R. C. *Materials of Construction*. Toronto, McGraw-Hill, 1968.

A descriptive treatment of all the major material involved in construction practices. Technical data is kept to a minimum, with Canadian standards. Cost, \$9.00.

## BIBLIOGRAPHY – (DIVISION 2)

Fletcher, Sir Bannister. *A History of Architecture*. 17th ed. Toronto, Oxford University Press, 1963.

Outlines the characteristic features of the architecture of each area of the world by comparing the buildings of each period and the geographical, religious, and social influences. Cost, \$18.00.

Green, Ronald. *The Architect's Guide to Running a Job*. 2d ed. London, England, Architectural Press, 1968 (Toronto, General Publishing).

This handbook is designed to be used as a tool by architects and their assistants in the day-to-day administration of a building contract. Topics from site inspection to briefing the painters are covered in this British text. Cost, \$3.50.

Halse, Albert O. *Architectural Rendering*. New York, F. W. Dodge Corporation, 1960 (Toronto, McGraw-Hill).

This book is an analysis of the pictorial method of rendering or delineation used by the architect in a design study. Cost, \$14.00.

Horstmann, F. C. *History of Building*. London, Sir Isaac Pitman and Sons Limited (Toronto, Sir Isaac Pitman and Sons).

A history of architecture from early civilization is included to show progressive ideas and the adaptations of structural design due to climate, available materials, and other influences. Cost, \$2.00.

Martin, Leslie C. *Architectural Graphics*. Toronto, Collier-Macmillan Canada Ltd., 1960.

A comprehensive coverage of orthographic and oblique drawing, perspective, and rendering as applied to buildings. Information is presented in a clear, simple manner. Cost, \$12.00.

Morgan, S. W. *Architectural Drawing*. Toronto, McGraw-Hill, 1950.

This text develops the theory of linear perspective, reduced to a few principles of universal application. Content: ten basic rules of perspective, rendering, special problems in shadows. Cost, \$12.00.

Ramsey, Charles G., and Sleeper, Harold R. *Architectural Graphic Standards*. New York, J. Wiley, 1956 (Rexdale, J. Wiley Canada).

All illustrative text which deals with all facets of architecture, using American Standards Association symbols, abbreviations, and codes.

Spence, William P. *Architecture*. Bloomington, Illinois, McKnight and McKnight Pub. Co., 1967 (Toronto, Heath, Elder Publications).

This text is designed as a comprehensive study of the planning and designing of residences and small, single-story, commercial buildings. A large segment of this text deals with commercial construction.

Stegman, George K., and Stegman, Harry J. *Architectural Drafting*. Chicago, American Technical Society, 1966 (Toronto, General Publishing).

The book covers site selection through every phase of construction details and home models. Illustrative material uses colour in step-by-step illustrations and explanations. Cost, \$8.50.

Sundberg, Elmer W. *Building Trades Blueprint Reading, Parts 1 and 2*. Chicago, American Technical Society, 1967 (Toronto, General Publishing).

Teaches blueprint-reading from actual blueprints, requiring no background in architecture or drafting. Content covers significant building trends, new types of specifications, and important developments in contemporary design. Cost, \$3.50.

See also the *Pelican Paperback Series on Famous Architects*. Don Mills, Longmans. A series of three books by Peter Blake entitled: Le Corbusier, Architecture and Form; Mies Van der Rohe, Architecture and Structure; Frank Lloyd Wright, Architecture and Space. Cost, \$1.75 each.

See also *The Great Ages of Man*. Toronto, Time-Life Books. P.O. Box 160. Visual and written presentations on architecture through the ages. A collection of books for a school library to be used as background material for teaching the history of architecture. Cost, \$5.00.



## BIBLIOGRAPHY — (DIVISION 3)

Burke, Arthur, and Dalzell, J. Ralph, and Townsend, Gilbert. *Architectural and Building Trades Dictionary*. American Technical Society, 1967 (Toronto, General Publishing).

Commonly used construction terms are defined with many illustrations to clarify the meanings and their relationship to the industry. Cost, \$7.50.

Dalzell, John R., and Townsend, Gilbert. *Masonry Simplified, Volumes 1 and 2*. American Technical Society, 1956 (Toronto, General Publishing).

A reference text for masonry, architecture, and masonry construction. A study guide is available for both volumes. Cost: text, \$7.00; guide, \$1.50.

Durbahn, Walter E. *Fundamentals of Carpentry*. 4th ed. Chicago, American Technical Society, 1967 (Toronto, General Publishing).

A basic text in light construction dealing with building techniques, tools, hardware, and the carpenter trade in general. Lots of colour illustrations.

Henderson, G. R. *Construction Safety*. Toronto, Copp Clark, 1966.

This Canadian text outlines safety practices, procedures, and responsibilities in the building and allied trades. First aid, Workmen's Compensation Board, fire prevention, and the Construction Safety Association are all dealt with.

Huntington, W. C. *Building Construction*. New York, J. Wiley, 1963 (Rexdale, J. Wiley Canada).

This text covers materials and types of construction including wood, steel, concrete, both cast-in-place and pre-stressed. Cost \$15.00.

Jones, Raymond P. *Framing, Sheathing and Insulation*. Toronto, Delmar, 1964. General and special framing practices are covered. Includes different types of roofs, dormers, and the application of insulating materials. Cost, \$4.00.

Merritt, F. S. *Building Construction Handbook*. Toronto, McGraw-Hill, 1965.

A collection of information on building design and construction. Covers such new developments as C.P.M. scheduling, new concrete and steel codes, and folded-plate and thin shell designs. Cost, \$20.00.

Miller, H. G. *Building Construction*. Toronto, Macmillan Co. of Canada Ltd., 1968. A Canadian text emphasizing principles and construction techniques in residential buildings. Hand tools, power tools, construction safety, and a glossary of terms are included. Cost, \$6.00.

New York State Education Dept. *Interior and Exterior Trim*. Toronto, Delmar, 1964. Contains the theory and practice common to the exterior and interior trim work of frame buildings. Cost, \$4.00.

Smith, Ronald C. *Principles and Practices of Heavy Construction*. Scarborough, Prentice-Hall of Canada Ltd., 1967.

A Canadian text which deals with the construction of permanent buildings using heavy timber, steel, concrete, or a combination of such materials. Modern soil testing methods and concrete design are well covered. Cost, \$12.00.

Smith, Ronald C. *Principles and Practices of Light Construction*. Scarborough, Prentice-Hall of Canada Ltd., 1963.

A Canadian text dealing with every aspect of a small building design which does not require reinforced concrete or steel frames. Includes a chapter on shop projects. Cost, \$11.00.

Wass, Alonzo, *Building Construction Estimating*. Scarborough, Prentice-Hall of Canada Ltd., 1963.

A comprehensive treatise on preliminary, detailed, and quantity estimating. Includes some legal aspects of land purchase, survey, and workmen's compensation. Cost, \$11.00.







